North Central Research Station News.....

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NEW ACOUSTIC DETECTOR HELPS LOCATE ASIAN LONGHORNED BEETLES

In the News.....

It's a scene straight out of a Tom Clancy novel: Chicago and New York City officials peering at wrist-band displays, waiting for signs (actually sounds), of dangerous fugitives in the street trees. The fugitives—Asian longhorned beetles that can kill even healthy hardwood trees—are real, and so is a new technology that can detect these voracious wood borers "en bite."

The beetle detector—a portable device that can hear the sounds of beetles chewing—is the brainchild of two groups of scientists: entomologists at North Central and acoustic specialists at the Department of Energy's Oak Ridge National Laboratory in Tennessee. "We needed a way to detect larvae [an early wormlike stage] in trees or in wooden packing materials, long before they're obvious to the eye," said Therese Poland, research entomologist with NC's Forest Insects unit in East Lansing.

Eavesdropping was the Answer

Knowing that wood borers make a chewing noise when carving out their galleries (feeding tunnels), NC contacted Cyrus Smith and his group at Oak Ridge's Instrumentation and Control Division. Smith's team had created many kinds of acoustic detectors, but they'd never been asked to build a bug for bugs. "By pairing our biological knowledge with their instrumentation skill," said NC's project leader Bob Haack, "we demonstrated how agencies can work together to protect natural resources."

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Therese Poland testing the acoustic beetle detector in China.

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Bob Haack injecting trees with pesticides in China.

Red Leaves Over Beijing: The Search for Pesticides

Thousands of trees leafed out this year in and near beetle-infested neighborhoods of Chicago and New York City. Worried homeowners want to protect the remaining trees or rid them of Asian longhorned beetle larvae. Short of felling the infested trees, can pesticides help?

Perhaps, says research entomologist Bob Haack and his team. They are trying to zero in on compounds that will solve the problem without creating a new one. "We're looking for high toxicity against wood borers, but low toxicity against everything else. It's best if the compounds can be injected directly into the trunk and then move systemically through the tree." The team decided to test three systemic compounds: imidacloprid, emamectin benzoate, and azadiracthin. Of the three, azadiracthin is environmentally preferred because it's created from an extract of the neem tree.

The team took these compounds to China and injected them into the trunks of infested trees. After a few months, they returned and cut half the trees to see how much beetle mortality had occurred. "Halfway into the study," Therese Poland said, "we're seeing 100% mortality among adults with imidacloprid and emamectin benzoate. We also see high mortality among larger larvae that feed in the conducting sapwood. So far, none of the compounds do especially well against smaller larvae that feed in the inner bark, and only azadiracthin kills pupae. It may be that we'll have to adjust the dosages, target the right life stage, or increase the number of injections per tree." Back in the States, the team is conducting controlled dosage and application studies.

Follow That Pesticide

Another part of what makes a pesticide effective is how completely it translocates, or spreads, throughout the tree. The assumption was that insect galleries in the wood, where larvae tunnel upward, would block transmission of water and insecticides. To test this, the team injected dye into infested trees, showing in a colorful way the probable path that the pesticide traveled. Within a day or two after injection, the trees were felled and split.

"Wood and leaves that received the dye turned a bright magenta," said Haack. When the dye reached a gallery, it moved close to the gallery walls and then spread out again when the dye reached the top of the gallery. "This finding suggests that larvae that are already present in wood at the time of injection could still encounter some insecticide as they feed and extend their galleries."

While a systemic pesticide may protect a tree for only 1 or 2 years, a naturalized population of natural enemies may be the gift that keeps on giving. NC research entomologist Leah Bauer (see next page) is one of an interagency group of insect pathogen experts looking at possible biological controls.

A Beetle's Natural Enemies are a Tree's Best Friend

"Colleagues send me their sick or dead insects, and I do a post-mortem exam on them," says Leah Bauer, explaining her approach to finding natural enemies that prey on an insect from the inside. When it comes to Asian longhorned beetle, she and colleagues from several institutions are looking for microorganisms such as viruses, fungi, bacteria, and protozoans that sicken or kill the beetles. "If we can find an effective natural enemy, we may be able to introduce it, or even better, simply augment populations of insect pathogens already found in Asian longhorned beetles in North America. This process of "naturalizing" the Asian longhorned beetle might be the next logical course of action if we can't eradicate the beetle soon."

Finding a Microscopic Silver Bullet

To prepare for this, Bauer traveled to China, searching through felled and split trees to collect dead beetles of all life stages. After "blenderizing" the insect bodies, Bauer centrifuged them to spin off fluids, leaving heavier particles, such as bacteria, viruses, or protozoans behind. The fateful moment will come in China or in the Connecticut quarantine, when Bauer inoculates Asian longhorned beetles with a potentially lethal pathogen.

What Bauer is looking for is not just a pathogen that kills insects, but one that kills Asian longhorned beetles exclusively. She calls it "narrow host specificity." "To find that, you have to gather the greatest possible diversity of pathogens from the bodies of dead insects," said Bauer. The best spot to find high diversity is a place where Asian longhorned beetles and their enemies have evolved for millennia. Bauer is hoping to visit several Chinese provinces on her next trip.

In the last few years, efforts by USDA APHIS (Animal and Plant Health Inspection Service) and Forest Service personnel have led to a greater understanding of how Asian longhorned beetles enter the country. Laws banning untreated wood packing material from China went into effect in 1999, and compliance, says Haack, has been very good. As a cautionary tale, he notes that the beetles, first discovered in 1996 in New York, probably entered in the early- to mid-eighties. "Even though we may be closing the door to new arrivals now, that door was open for many years."

▲ From left to right Leah Bauer, Tonghai Zhao (incoming post-doc from Bejing), and Therese Poland.

Hopefully, the beetles that walked through that door and into our cities will be detected and controlled soon, thanks to a blend of high-tech equipment and hands-on biology.

◀ Microorganisms found in the bodies of Asian longhorned beetles from China could provide the key to biological control in the U.S.

When Your Backyard is Ground-Zero: Social Research Helps Improve Communication About Beetle Control

Sometimes, in our zeal to eradicate an exotic insect like the Asian longhorned beetle, we forget that the tree that must be sacrificed is somebody's favorite. When Sue Barro, research social scientist from NC's Urban Forests unit in Chicago, heard entomologists discussing possible alternatives for the next phase of containment, she wondered what homeowners would say if they were in the room. "What works biologically is only one part of the equation," Barro said. "People have to support the control effort or it won't happen."

Sue Barro

To learn more about public perceptions, Barro conducted eight focus groups—two with people from Chicago's core infestation area who had lost trees, two with core residents who hadn't lost trees, two with people outside the core but inside the 14-square-mile quarantine zone, and two with people outside the quarantine zone. Each group had 5-10 people, for a total of 64 participants. A moderator asked the groups what they thought of the current control strategy (cutting infested trees) as well as two alternatives—injecting pesticides in trees within a certain radius of infested trees, or cutting down susceptible trees within that radius.

The focus groups preferred the current eradication strategy above all the others. The second most preferred strategy was the insecticide option, although group participants did have reservations. They asked detailed questions such as "Where in the tree will the insecticide be injected?" and "Can it leach from the tree into the soil?"

Good Question!

"When people turn their attention to natural resource issues that affect them, they become intellectually curious, and they ask good questions," Barro said. "We were lucky to work with NC's answer-entomologists Bob Haack and Therese Poland, as well as with State and Private Forestry entomologist Dennis Haugen and communications officer Gina Childs. After each session, we got better at addressing public concerns on the spot."

Better public communication is the whole point of the study. Cooperator Karen Vigmostad, a technology transfer specialist at Michigan State University, asked group participants which information was most helpful to them, and what other kinds of information they would like. From these insights, Vigmostad will create an informational brochure for homeowners and a tip sheet of "best communication practices" for government officials and scientists.

Meanwhile, Barro is analyzing people's spoken questions and comments, and will summarize these to help resource professionals in other cities who may someday deal with the same situation.

Tips for Public Officials

If and when emergencies develop in other cities, the findings of this study should help improve public contacts. Sue Barro recommends the following:

- Contact homeowners directly if trees in or near their yard must be removed.
- Keep homeowners well-informed at all stages of the process, even during followup.
- Get public support for a control strategy before it's adopted.
- If a combination of different strategies is used, make sure officials are well-versed in the tradeoffs among the strategies so that the public hears one clear and consistent message.

The greatest tip that Barro has for officials is this: "As long as a current strategy keeps the beetle at bay, most homeowners would like to stay with it until research identifies a better one. The new strategy will only be accepted if there is no other alternative, if it is scientifically tested, and if it is thoroughly explained." That sounds only fair, especially if we're talking about losing someone's favorite tree.

Atlas of Lakes "Most Likely to Be Developed"

For city dwellers with a place on the lake, Friday night can't come soon enough. For local lake residents, the night to savor is Sunday (when the weekenders leave!).

More of both types of owners are moving to the water's edge, and with them: more buildings, more docks, more boats, and more pressure.

"Like anything in danger of being loved to death, northern lakes need wise planning and management," says Pam Jakes, project leader of NC's Social Science unit in St. Paul.
"Some counties have more than a hundred lakes, but only one or two planners. What they need is a way to predict which lakes are most likely to attract development so they can focus their efforts."

Repurposing Existing Data

Jakes, together with University of Minnesota Professor Dorothy Anderson and graduate student Ciara Schlichting, are creating that predictive device by viewing existing data through a new lens. "We found a way to profile lakes using features that perspective buyers and developers care about," Jakes said.

According to a study by the Minnesota Department of Natural Resources (DNR), people prefer living on lakes that have access to roads, with lots of sandy beaches and large trees. Another study found that development was densest on lakes near population and retail centers. Some lakes have proximity and attractiveness, but lack private land or proper soils to support septics. "The challenge is to combine the social and the biophysical data into a single picture that reflects development potential," Jakes said.

The researchers chose Itasca County near Grand Rapids, MN, for their study site because of a wealth of available data, including decades of study by NC biologists and hydrologists. "Conducting our studies on a common site creates synergies," said Jakes, "and that's the whole idea of integrated research."

For mapping purposes, they divided the land surrounding the 164 lakes into half-acre cells, classifying each cell by ownership, category of land use, soil type, distance to roads, type of vegetative cover, and more. They converted these factors into ranking systems that were relevant to buyers, developers, and planners.

Novel Visual Display

Ease-of-use was a major consideration in data reporting. "We wanted people to see at a glance how a lake stacked up against all the others in the county," Jakes said.

"Instead of just listing houses per mile of shoreline, for instance, we portrayed relative density by quartile: Is it more or less densely developed than other lakes?"

"Seeing where the ranking falls is a lot easier than sorting through reams of numbers," Jakes said.

The team's final product will be an atlas of Itasca lake maps and profiles. It's one of a range of policy-relevant tools under development in NC's integrated programs: Riparian Landscapes, Landscape Change, and Forest Productivity.

How might the atlas be used? "A planner can see that a lake is ripe for development, but is also fragile in terms of water quality. This raises the need for careful septic and access review," said Jakes. "Seeing which shorelines are fragmented may help DNR managers decide where to build a developed boat launch, or where a simpler put-in would make sense."

"It's important to understand how a lake fits and what purpose it serves in the larger landscape," Jakes said. "Our atlas will give people a bird's eye view of Itasca's possible future."

▸ Lakeshore development.

An Awarding Career: Richard Dickson's 32 Years of Service

Over his 32-year career with the North Central Station, research plant physiologist Richard Dickson became an internationally known researcher in the field of tree physiology as well as the recipient of several major awards. He was the first scientist to be awarded the North Central Distinguished Science Award for his research on photosynthetic fixation, translocation, and metabolism of carbon in forest trees. He also received both the Forest Service and the U.S. Department of Agriculture Distinguished Science Awards for adding fundamental understanding about the effects of changing environmental stresses on physiological processes and the regeneration of high-value tree species in northern hardwood forests.

▲ Richard Dickson.

Dickson began his North Central career in 1968, shortly after receiving his Ph.D. Beginning with NC's former Hardwood Plantation Establishment unit in Ames, IA, he moved to Rhinelander in 1970 to work with Phil Larson's pioneer research project, Physiology of Wood Formation.

Dickson's early research included wood chemistry, carbon physiology and the transport of carbon in plants, and techniques for the localization of water-soluble ^{14}C-labeled compounds. His later work involved the influence of environmental stresses on growth and physiological responses of northern red oak, aspen, white pine, and several other species.

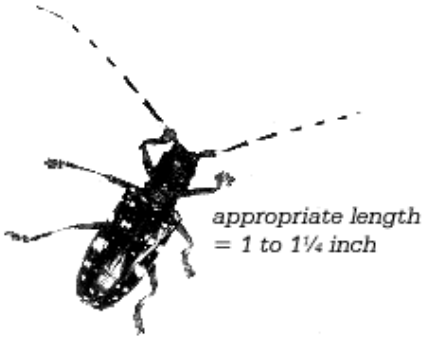
When asked what he was most proud of in his career, Dickson replied, "Being involved with the Aspen Free-Air Carbon dioxide Enrichment (FACE) project right from the start." And that pride shows in his career-closing labor of love: writing (with several co-authors) and preparing for publication the definitive overview of the Rhinelander FACE project, which will come out soon as a Station General Technical Report GTR-NC-214.

Dickson officially retired on May 3, but he continues to volunteer at the Rhinelander Lab to tie up the loose ends of the various research projects he's been involved with over the years. Project Leader Jud Isebrands is pleased that Dickson has chosen to work part time with the unit during his retirement. "I have enjoyed my 30+ years working with Richard," said Isebrands. "He is a world-class scientist and a world-class man to work with."

Beetle Detection
(continued from page 1)

NC staff took four species of native wood borers down to Tennessee so analysts could record their munching. After several weeks of listening, they identified a sound pattern common to wood borers. The beetle detector compares this pattern to sounds from an infested tree, looking for a match.

To test the detector, NC and Oak Ridge staff recorded Asian longhorned beetles at the Northeastern Research Station's quarantine facility in Ansonia, Connecticut. Their next stop was China, where they recorded larvae feeding in live trees in their native habitat. (Korea is their other home ground.)



▲ Asian longhorned beetle.

They counted how many insects were there, how large they were, and how far from the sensor they were. Differences among tree species were also noted. "Wood cell structure and density differ among tree species, so sound propagation will vary from tree to tree," Poland said.

"We expect the detector will work best in living trees where the larvae are most active and in crates and pallets made from green [moist] lumber," Haack said. In drier materials, larval development and beetle chewing slow to a crawl, meaning fast scans can miss the occasional bite.

To detect beetles in drier wood, Haack is thinking about another device: a snooping nose. "If we can build a sensor for sound, we may be able to build one that sniffs out insect frass (a mixture of boring dust and feces) or other chemical cues issuing from a newly opened packing crate," Haack said. "Either way, we hope to stop the beetles long before they leave the dock."